

UNITED STATES DEPARTMENT OF COMMERCE  
NATIONAL BUREAU OF STANDARDS  
WASHINGTON

Letter  
Circular  
LC-502D

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RAIN PENETRATION IN WALLS, WATERPROOFING OF MASONRY  
WALLS AND THE PROPERTIES OF JOINTS IN MASONRY  
IN RELATION TO LOW-COST HOUSING

I. Purpose

1. General.--As indicated in Letter Circular LC-502, which explains the objectives, procedure and scope of the program of research on materials for low-cost housing, an investigation of rain penetration in masonry walls is included as one of the special problems. This Circular describes the investigations of water permeability of wall constructions and of the strength and permeability of joints. Prefabricated elements for the walls of housing structures will be tested to determine their permeabilities under exposures simulating wind driven rains. In addition, methods of waterproofing masonry walls of conventional designs but of several combinations of materials, design, and kind of workmanship will be investigated. As it will not be possible to include, in the studies of rain penetration and mechanical properties of masonry walls, many of the variable factors which are apt to affect these properties of walls, those studies will be supplemented by an investigation of the permeability and the shearing and tensile strengths of joints in brick masonry.

2. Tests of prefabricated elements.--The tests of prefabricated elements are intended to provide measures of their resistances to rain penetration, as constructed, and information which may indicate how constructions which are not resistant may be improved.

3. Tests of masonry walls.--The tests on masonry walls are intended to provide measures of the rain resistance of conventional types of masonry wall constructions, thereby indicating what performances should be demanded of new types. They are planned to develop also information on the merits of various waterproofing treatments and on the effects of variations in design, materials and methods of construction on the rain resistance of masonry walls. It is expected that the data obtained will indicate how penetration of moisture in masonry walls may be minimized by methods which do not increase significantly the cost of constructions which are suitable for low-cost housing structures.

4. Tests of joints in brick masonry.--The tests are intended to yield information on the effects of qualities of bricks and mortars, the condition of the bricks when laid and curing conditions upon the permeability and strengths of joints in brick masonry. Inasmuch as the permeability and some mechanical properties of brick walls are largely functions of similar properties of joints, it is expected that the data on joints will indicate how those properties of walls are affected by these variable factors.

## II. Masonry Walls

1. Waterproofing treatments.--The waterproofing treatments for masonry walls of conventional designs will include applications to the interior surfaces of bituminous mastic, hot asphalt, bituminous solutions, mortar parging, iron waterproofing and brush coatings of cement grout; grouting of the exterior face joints, and coatings of cement paint, oil paint and colorless solutions on the exposed faces.

2. Designs and materials for walls.--The designs of the walls and the materials used in their construction will be selected to provide information on the effects of the following factors on the resistance of masonry walls to rain penetration: qualities of bricks and mortars, methods of filling joints in masonry, parging of mortar on facing or backing tier, tooling of face joints, and combinations of clay tile and concrete block with brick facings. In addition studies will be made of the effects of the kind of backing, composition, texture and curing conditions for stucco facings on their value in resisting penetration of moisture.

3. Specimens and methods of testing.--Walls approximately 50 in. high and 40 in. long will be subjected to an exposure simulating that caused by wind and rain. The prefabricated elements will be supplied by the sponsors; the masonry walls of conventional designs and materials will be constructed, in the laboratory, of materials of known properties. During a test water will be applied to one face of a

wall, by means of a horizontal perforated pipe near the top of the wall, at the rate of 15 gal per lin ft per hr. The effect of wind pressure will be simulated by maintaining a static air pressure against the exposed face of the wall equal to 10 lb per sq ft. During the exposures observations will be made of the time for moisture to penetrate the wall, the rate of leakage through the wall and the area of the back of the wall which becomes damp during the first 24 hours.

### III. Joints in Brick Masonry

Since the bricks and mortars in commercial use represent a much wider range of properties than are represented by the types selected for the walls and since the building of additional 50 by 40 in. walls sufficient in number to adequately represent these other types of materials would add greatly to the expense and time of the investigation, the study of the effect of brick properties and mortar properties will be extended by making the tests on the following materials:

1. Kinds of brick.--Absorption, rate of absorption, texture and strength, covering the range commercially represented by the brick production of the United States, are included in a selection of 18 types of bricks selected on the basis of a previously made investigation of the properties of bricks produced in the United States. The effect of "salvaged" bricks will be studied by using in part bricks previously tested in combination with mortar and thereafter cleaned.

2. Kinds of mortar.--Mortars will include mixtures of portland cement, lime and sand, ranging in proportions from 1:3 lime-sand by volume, to 1:0.2:3 cement-lime-sand by volume. For these cement-lime mortars three kinds of lime will be used, one each of low, medium and high plasticity. There will be included also mortars containing a representative brand of each of the 4 types of composition for commercial masonry cements.

3. Specimens.--Specimens for permeability tests will consist of masonry piers, about 8 by 18 by 18 in. The exposed faces will be turned to a horizontal position and impounded with 1 in. of water while under test. Specimens for shearing tests of joints will consist of 3 bricks bonded together with mortar and those for transverse tests will consist of 7 bricks. Representative samples of the bricks will be tested to determine compressive and transverse strengths, total absorptions and rates of absorption. The mortars will be tested to determine compressive strengths, water-retaining capacities, absorption and a measure of permeability. With at least one type of highly absorptive bricks the suction of the bricks will be varied by controlling the moisture content and these bricks will be used with mortars of at least 2 consistencies.

